CLAIMS

1. A system for applying a laser beam to work pieces, comprising:

a laser system producing an output beam;

target delivery optics arranged to deliver said output beam to a target work piece;

a relay telescope having a telescope focal point in a beam path between the laser system and the target delivery optics which relays an image between an image location near an output of the laser system and an image location near said target delivery optics; and

a baffle at the telescope focal point.

2. The system of claim 1, wherein said laser system includes:

a gain medium;

a polarization rotator;

a passive polarizer;

a plurality of reflectors configured to define an optical path through the gain medium, the passive polarizer, and the polarization rotator;

a phase conjugator configured to receive a beam from the optical path after the pulse has proceeded one or more transits through the optical path, the phase conjugator further configured to return the beam with reversed phase to the optical path to proceed an equal number of transits of the optical path in an opposite direction before exiting the optical path at said passive polarizer; and

an intra-cavity relay telescope having a telescope focal point, between the gain medium and the passive polarizer, which is used for relaying images between the gain medium and a location near the output of the laser system.

3. The system of claim 1, wherein said baffle comprises a pinhole baffle.

4. The system of claim 1, wherein said baffle comprises a tapered baffle.

5. The system of claim 1, wherein said relay telescope comprises:
a first relay lens;
a second relay lens;
a vacuum chamber between the first and second relay lenses, the first and second relay lenses focusing beams at the telescope focal point within the vacuum chamber;
a mount within the vacuum chamber, adapted to secure the baffle near the telescope focal point;
a view port on the vacuum chamber providing a view of the baffle for alignment; and
an access port on the vacuum chamber, adapted for insertion and removal of the beam baffle.

6. The system of claim 1, wherein said output beam comprises pulses having a pulse width of less than 30 nanoseconds and energy greater than 10 joules/pulse on the target work piece.

7. The system of claim 1, wherein said laser system includes:
a gain medium;
a polarization rotator;
a passive polarizer;
a plurality of reflectors configured to define an optical path through the gain medium, the passive polarizer, and the polarization rotator; and
a phase conjugator configured to receive a beam from the optical path after the

pulse has proceeded one or more transits through the optical path, the phase conjugator further configured to return the beam with reversed phase to the optical path to proceed an equal number of transits of the optical path in an opposite direction before exiting the optical path at said passive polarizer;

a first intra-cavity relay telescope having a first intra-cavity telescope focal point, between the gain medium and the passive polarizer, which is used for relaying images between the gain medium and a location near the output of the laser system, including a first intra-cavity baffle near the telescope focal point; and

a second intra-cavity relay telescope having a second intra-cavity telescope focal point, between the passive polarizer and the phase conjugator, which is used for relaying images of an output of the gain medium between a location near the passive polarizer and a location at the phase conjugator, including a second intra-cavity baffle near the second intra-cavity telescope focal point.

8. A system for laser shock peening work pieces, comprising:

a laser system producing an output beam comprising pulses;

a work piece robot cell, which positions work pieces to receive the output beam and conditions the work pieces for laser shock peening;

target delivery optics arranged to deliver said output beam to a target work piece;

a relay telescope having a telescope focal point, in a beam path between the laser system and the target delivery optics, which relays an image between an image location near an output of the laser system and an image location near said target delivery optics; and

a baffle at the telescope focal point to block off angle and out of focus back reflections from one or both of the target delivery optics and the work piece robot cell.

9. The system of claim 8, wherein said laser system includes:

a gain medium;

a polarization rotator;

a passive polarizer;

a plurality of reflectors configured to define an optical path through the gain medium, the passive polarizer, and the polarization rotator; and

a phase conjugator configured to receive a beam from the optical path after the pulse has proceeded one or more transits through the optical path, the phase conjugator further configured to return the beam with reversed phase to the optical path to proceed an equal number of transits of the optical path in an opposite direction before exiting the optical path at said passive polarizer; and

an intra-cavity relay telescope having a telescope focal point, between the gain medium and the passive polarizer, which is used for relaying images between the gain medium and a location near the output of the laser system.

10. The system of claim 8, wherein said baffle comprises a pinhole baffle.

11. The system of claim 8, wherein said baffle comprises a tapered baffle.

12. The system of claim 8, wherein said relay telescope comprises:

a first relay lens;

a second relay lens;

a vacuum chamber between the first and second relay lenses, the first and second relay lenses focusing beams at the telescope focal point within the vacuum chamber;

a mount within the vacuum chamber, adapted to secure the baffle near the telescope focal point;

a view port on the vacuum chamber providing a view of the baffle for alignment; and

an access port on the vacuum chamber, adapted for insertion and removal of the beam baffle.

13. The system of claim 8, wherein said output beam comprises pulses having a pulse width of less than 30 nanoseconds and energy greater than 10 joules/pulse on the target work piece.

14. The system of claim 8, wherein said laser system includes:

a gain medium;

a polarization rotator;

a passive polarizer;

a plurality of reflectors configured to define an optical path through the gain medium, the passive polarizer, and the polarization rotator; and

a phase conjugator configured to receive a beam from the optical path after the pulse has proceeded one or more transits through the optical path, the phase conjugator further configured to return the beam with reversed phase to the optical path to proceed an equal number of transits of the optical path in an opposite direction before exiting the optical path at said passive polarizer;

a first intra-cavity relay telescope having a first intra-cavity telescope focal point, between the gain medium and the passive polarizer, which is used for relaying images between the gain medium and a location near the output of the laser system, including a first intra-cavity baffle near the telescope focal point; and

a second intra-cavity relay telescope having a second intra-cavity telescope focal point, between the passive polarizer and the phase conjugator, which is used for relaying images of an output of the gain medium between a location near the passive polarizer and

a location at the phase conjugator, including a second intra-cavity baffle near the second intra-cavity telescope focal point.

15. A method for laser shock peening a target work piece, comprising:

coupling a seed pulse into a ring shaped optical path including an amplifying medium;

first relaying an image of an output of the amplifying medium to SBS phase conjugation system;

phase reversing the pulse in the SBS phase conjugation system after one or more transits through the ring in which the pulse traverses the amplifying medium;

second relaying an image of the output of the amplifying medium to an output coupler, after the pulse traverses the amplifying medium in an equal number of transits through the ring in an opposite direction to provide a wavefront corrected output pulse;

coupling the wavefront corrected output pulse comprising the image of the output of the amplifying medium out of the ring at the output coupler, and

controlling a pulse width of the wavefront corrected output pulse by controlling a threshold of said SBS phase conjugation system;

third relaying an image of the wavefront corrected output pulse via a relay telescope to target delivery optics;

delivering the wavefront corrected output pulse to the target work piece; and

blocking back reflections using a baffle in the relay telescope.

16. The method of claim 15, wherein said SBS phase conjugation system comprises a collimated SBS cell and a focused SBS cell in the cavity.

17. The method of claim 15, wherein said SBS phase conjugation system comprises a collimated SBS cell and a focused SBS cell in the cavity, and said controlling the pulse

width includes diverting a controlled amount of energy from said pulse out of the cavity between the collimated SBS cell and the focused SBS cell to control said threshold.

18. The method of claim 15, wherein said SBS phase conjugation system includes an SBS medium in said cavity, the SBS medium comprising a compound having an non-linear index of refraction of less than about 10^{-12} esu.

19. The method of claim 15, wherein said SBS phase conjugation system includes an SBS medium in said cavity, and including filtering said SBS medium *in situ* to remove particles having a size greater than about 0.1 microns.

20. The method of claim 15, wherein said SBS phase conjugation system includes a collimated SBS cell and a focused SBS cell in the cavity; and

aligning the optical cavity using an alignment fiducial between the collimated SBS cell and the focused SBS cell.

21. The method of claim 15, wherein said first and second relaying includes using at least one relay telescope having an intra-cavity telescope focal point, having a baffle at said intra-cavity telescope focal point to block off angle beams.